Track reconstruction efficiency

A. Rakitin

Lancaster University

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Tralgo Meeting
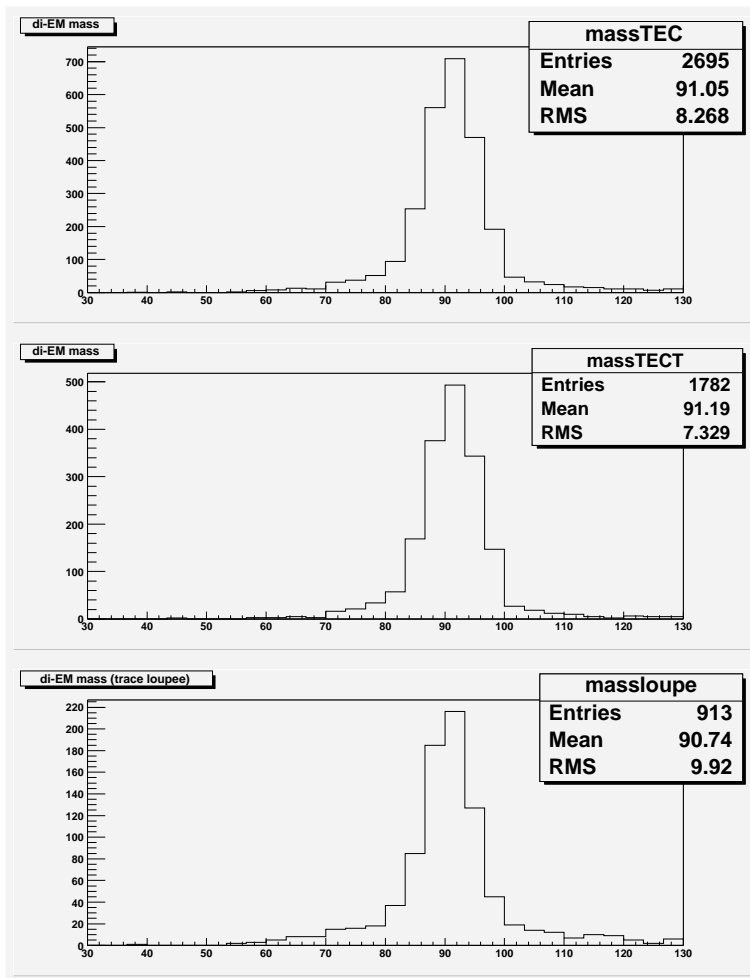
http://www-d0.fnal.gov/~rakitin/d0_private/tex/2006.Mar.23.Tralgo/tr.pdf

Tracking efficiency study:

Reminder: I use Jan Stark's data sample $Z \rightarrow e^+ e^-$:

- One EM cluster in CC ("tag electron") – must have matching track
- Another EM cluster in end-caps ("probe electron") – does not have to have matching track

The plots of di-EM mass (© Jan Stark):

- Upper: all events
- Middle: probe electron has matching track ($\sim$66%)
- Lower: probe electron has no matching track ($\sim$34%)

- **Problem:** matching track isn't reconstructed
  for probe electron in one-third of cases
- **Resolution:** slight change of reconstruction
  algorithm may help

Method of study:

- Shoot an imaginary track from PV to EM cluster
- See which hits are close to it
- Understand why they were not composed into track

In my study I only use first 40 events from the sample in the lower plot

Reminder of proposed change in algorithm:

- All the tracks having 3+ hits in SMT Barrels are reconstructed with current algorithm

- Non-reconstructed tracks can be divided into 4 categories:
  - ☞ Tracks with
    either 2 hits in SMT barrels and 1 in F-disks
    or 1 hit   in SMT barrels and 2 in F-disks
    (14 tracks out of 40)

  - ☞ Tracks with 2 hits in SMT and 4+ in CFT (6 out of 40)
  - ☞ Tracks with hits being further than "standard" 3σ window (2 out of 40)
  - ☞ "Invalid" tracks with too few axial or stereo hits (5 out of 40)
  - ☞ Tracks with too few hits to be reconstructed (13 out of 40)

By changing tracking algorithm we can reconstruct first three categories

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Combinatorics will increase $\Longrightarrow$ must do timing studies too

First two changes are currently under investigation

Results

☞ SMT hits in barrels and disks may follow different patterns:

- 2 in barrels + 1 in disk
- 1 in disk + 2 in barrels
- 1 in barrels + 1 in disk + 1 in barrel

☞ To take all these combinations into account let each hit be either in SMT barrel or in SMT disk

☞ Changed algorithm found 5 more tracks in sample of 40 events
$\Longrightarrow$ tracking inefficiency decreased by 13%

☞ Unfortunately, changed algorithm does not find many tracks because the hits are too far from expected positions (8 out of 14 in addition to 2 from old algorithm)

☞ Time to find all tracks within one event increases by approximately factor of 2

Let's go through these results in detail...

"2+1" or "1+2" SMT hits:

Run/Event	Electron	SMT Barrels	CFT	SMT F	SMT H	Reconstructed?	Reconstructible?
164605 10233199	Probe	2	3	2	0	YES	Yes
	Tag	6	7	0	0	Yes	Yes
165805 2576564	Probe	2	2	2	0	YES	Yes
	Tag	0	7	1	0	Yes	Yes
166113 39215346	Probe	1	3	2	0	YES	Yes
	Tag	4	8	1	0	Yes	Yes
166295 20638511	Probe	1	0	2	1	No, invalid	???
	Tag	3	8	0	0	Yes	Yes
166302 24938931	Probe	1	3	2	0	No, hits too far	???
	Tag	3	8	0	0	Yes	Yes
166302 24109618	Probe	1	3	2	0	YES	Yes
	Tag	4	8	0	0	Yes	Yes
166506 46965463	Probe	2	4	1	0	No, hits too far	???
	Tag	2	8	0	0	Yes	Yes
164445 2159216	Probe	1	2	2	0	No, invalid	???
	Tag	2	8	2	0	Yes	Yes
166782 123665141	Probe	1	3	2	0	No, hits too far	???
	Tag	3	8	0	0	Yes	Yes
164605 7263701	Probe	1	3	3	0	No, hits too far	???
	Tag	2	8	0	0	Yes	Yes
166937 9714345	Probe	2	2	2	0	No, hits too far	???
	Tag					Yes	Yes
167325 3178494	Probe	1	1	2	0	No, hits too far	???
	Tag					Yes	Yes
168498 519484	Probe	1	2	2	0	No, hits too far	???
	Tag					Yes	Yes
168973 5391969	Probe	2	2	1	0	No, hits too far	???
	Tag					Yes	Yes

2 SMT hits and 4+ CFT hits (not investigated yet):

Run/Event	Electron	SMT Barrels	CFT	SMT F	SMT H	Reconstructed?	Reconstructible?
165977 6659303	Probe	2	4	0	0	No, 3-hit req.	Yes
	Tag	0	5	0	0	Yes	Yes
163171 48542536	Probe	1	4	1	0	No, 3-hit req.	Yes?
	Tag	0	8	0	0	Yes	Yes
163171 46651698	Probe	0	4	2	0	No, 3-hit req.	Yes?
	Tag	1	8	0	0	Yes	Yes
164039 14995544	Probe	0	4	2	0	No, 3-hit req.	Yes?
	Tag	3	8	0	0	Yes	Yes
166869 37137074	Probe	0	5	2	0	No, 3-hit req.	Yes?
	Tag	0	8	1	0	Yes	Yes
166868 36065427	Probe	1	4	1	0	No, 3-hit req.	Yes?
	Tag	3	8	0	0	Yes	Yes

Hits too far from track (with non-changed algorithm):

Run/Event	Electron	SMT Barrels	CFT	SMT F	SMT H	Reconstructed?	Reconstructible?
164080 30329930	Probe	0	7	0	0	No, hits too far	Yes?
	Tag	1	5	0	0	Yes	Yes
166872 41058810	Probe	0	5	1	0	No, hits too far	Yes?
	Tag	2	8	0	0	Yes	Yes

Invalid tracks:

Run/Event	Electron	SMT Barrels	CFT	SMT F	SMT H	Reconstructed?	Reconstructible?
164216 83479647	Probe	0	1	3	0	No, invalid	???
	Tag	1	7	0	0	Yes	Yes
164018 11142735	Probe	0	1	4	0	No, invalid	???
	Tag	3	8	1	0	Yes	Yes
164040 18660971	Probe	4	5	0	0	YES	Yes
	Tag	2	8	0	0	Yes	Yes
164083 35308948	Probe	0	0	3	0	No, invalid	???
	Tag					Yes	Yes
168525 19495531	Probe	4	5	1	0	YES	Yes
	Tag					Yes	Yes

Too few hits to reconstruct track:

Run/Event	Electron	SMT Barrels	CFT	SMT F	SMT H	Reconstructed?	Reconstructible?
165645 5273011	Probe	2	2	0	0	No	No, too few hits
	Tag	3	7	0	0	Yes	Yes
164636 16204878	Probe	0	0	2	0	No	No, too few hits
	Tag	0	8	1	0	Yes	Yes
165765 36883677	Probe	0	3	1	0	No	No, too few hits
	Tag	3	8	0	0	Yes	Yes
165686 45005141	Probe	0	2	1	0	No	No, too few hits
	Tag	2	8	1	0	Yes	Yes
164385 4847391	Probe	0	4	2	0	No	No, too few hits
	Tag	3	8	0	0	Yes	Yes
164382 3507437	Probe	0	2	0	0	No	No, too few hits
	Tag	0	7	0	0	Yes	Yes
166483 3946198	Probe	0	0	0	1	No	No, too few hits
	Tag	0	7	0	0	Yes	Yes
163172 49593518	Probe	0	0	0	0	No	No, too few hits
	Tag	0	7	0	0	Yes	Yes
166776 115353883	Probe	0	0	0	0	No	No, too few hits
	Tag	0	8	0	0	Yes	Yes
164605 6649931	Probe	0	0	1	1	No	No, too few hits
	Tag	0	8	0	0	Yes	Yes
164095 44036204	Probe	0	1	1	0	No	No, too few hits
	Tag	4	8	1	0	Yes	Yes
166898 16826502	Probe	0	3	2	0	No	No, too few hits
	Tag	1	8	0	0	Yes	Yes
168732 17138782	Probe	0	4	1	0	No	No, too few hits
	Tag					Yes	Yes

Timing studies
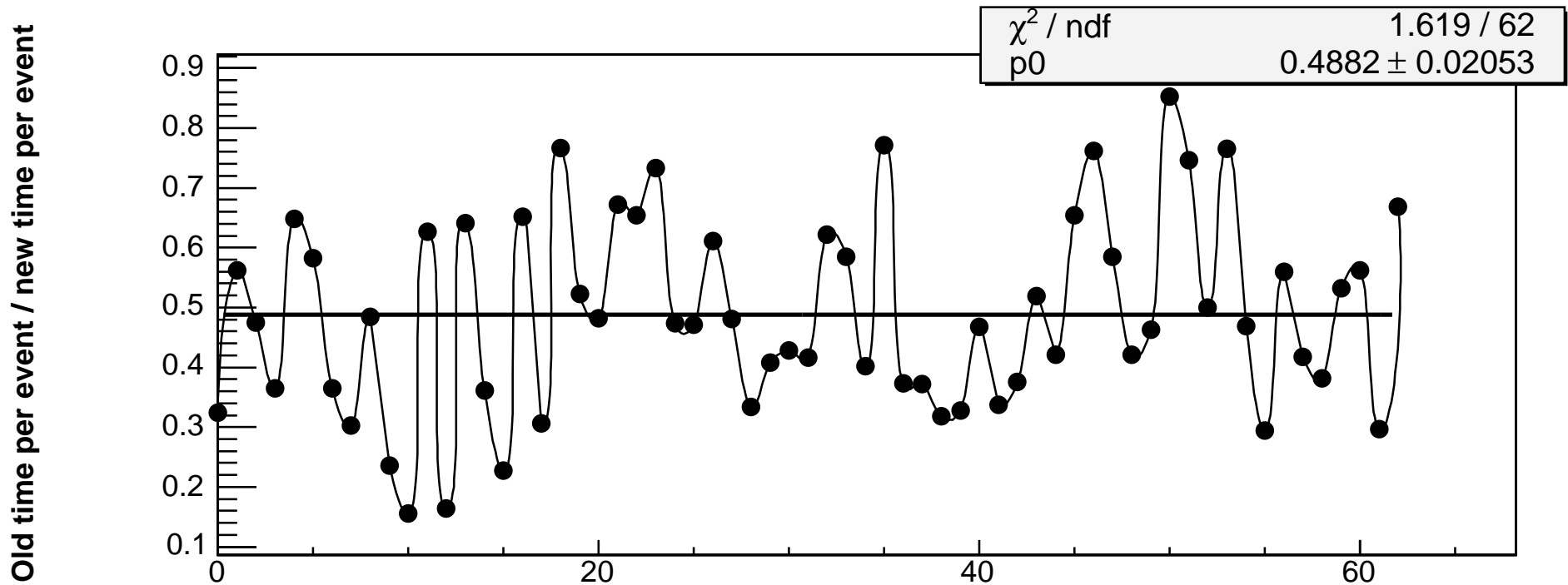
Fit with horizontal line $\Longrightarrow$ obtain 0.49 ± 0.02

$\Longrightarrow$ time per event increases approximately by factor of 2

Conclusion

Majority of the missing tracks from the "probe" electrons
can be reconstructed by slight variations of the algorithm:

- Require 3+ hits in **both** SMT barrels and disks, not only in barrels
  - diminish tracking inefficiency by 13%
  - processing time increases by approximately factor of 2

- Allow hits to be further than 3σ away (maybe only for high-p_t tracks?)
  $\implies$ to be investigated

- Allow for 2 hits in SMT (barrels and disks) if CFT has 4+ hits
  $\implies$ to be investigated